AIR COOLED FAST DISCHARGE RESISTORS FOR ITER MAGNETS

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The ITER superconducting magnet system will store up to 60 GJ of magnetic energy during the machine operational cycle. In case of coil quench or a serious failure in the power supply system the energy stored in the coils must be extracted rapidly - with the time constant of 7 to14 second. This will be achieved with the help of fast discharge resistors (FDR) normally bridged by circuit breakers and inserted in series with the superconducting coils, when fast discharge is initiated.
The FDR design is based on unified resistor modules made of steel tapes in a tight serpentine pattern to minimize module inductance to 3÷4 μH. Each module comprises several sections electrically connected in parallel. The sections in the modules are placed vertically: one above another. Each toroidal field (TF) module is formed from 4 sections; the poloidal field (PF) modules and central solenoid (CS) modules have 3÷4 and 2 sections each respectively. Each module is equipped with one cooling air delivery unit (intake duct) located at the bottom and one air extraction unit (exhaust duct) on the top of the module. The modules forming one resistor are arranged in several lines (from 2 to 4). All modules within each line are mechanically connected and form one branch of air-cooling.
The fast discharge of the coils results in practically adiabatic heating of the resistive elements up to 200÷300°C. The resistors need to be cooled to the initial temperature over 6÷8 hours. Natural air circulation is proposed as a method for FDR cooling.
The calculation model of the FDR cooling network (Fig. 1) is developed for (i) simulation of thermal response of the resistors to more than 50 GJ of energy releasing inside the resistive plates and, (ii) demonstration of the air natural circulation capability to cool the FDRs within the specified time.
The computation reveals that the proposed design of the FDR cooling system based on the natural air circulation, in general, is capable to provide the required temperature regimes, but the air supply ducts have to be optimized to ensure the acceptable cooling duration for the FDRs (Fig. 2). The experiments carried out on the TF module prototype verified the computation results.

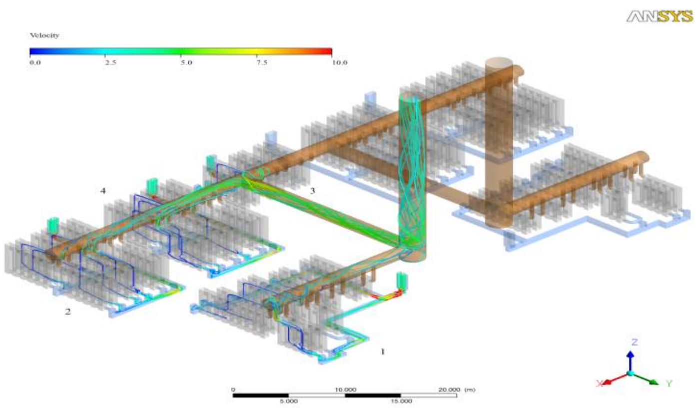

Fig. 1 CFX model of the FDR air cooling network

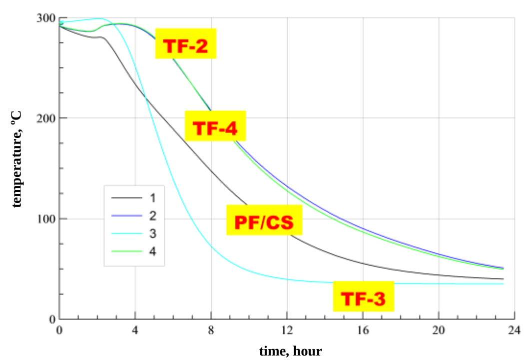

Fig. 2 FDR cooldown time (hours)